



## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Simon Charles Goodacre  
Serial No.: 10/697,210 Case No.: T1592  
Filed: October 30, 2003  
For: IMIDAZO[4,5-C]PYRIDIN-4-ONE ANALOGUES AS  
GABA RECEPTOR LIGANDS

Commissioner for Patents  
Alexandria, VA 22313

SUBMITTAL OF PRIORITY DOCUMENT

Sir:

Enclosed please find a certified copy of the following priority document for submittal with respect to the above-noted application:

Foreign Application - Great Britain 0225399.5 October 31, 2002

Respectfully submitted,

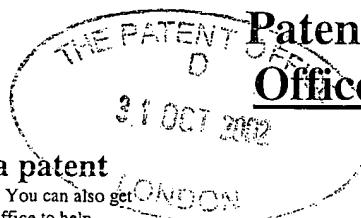
By   
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Date: February 17, 2004

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By J. Eric Thies Date 17 Feb 2004  
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Patent 1977  
(Rule 1c)

1/77

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1. Your reference

T1592PV

2. Patent application number

(The Patent Office will fill in this part)

0225399.5

31 OCT 2002

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Merck Sharp & Dohme Limited  
Hertford Road, Hoddesdon  
Hertfordshire EN11 9BU  
United KingdomVIRUV02 E760162-1 0025399.5  
P01/7701 31.10.02-0225399.5

Patents ADP number (if you know it)

00597799001

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

4. Title of the invention

Therapeutic Agents

5. Name of your agent (if you have one)

Dr. J. Thompson

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Merck & Co., Inc.  
European Patent Department  
Terlings Park  
Eastwick Road  
Harlow  
Essex CM20 2QR

Patents ADP number (if you know it)

4392742002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority Application number  
(if you know it)Date of filing  
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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day/month/year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

- a) any applicant named in part 3 is not an inventor, or
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See note (d))

Patents Form 1/77

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Description	36	
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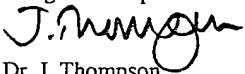
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10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	-
Request for preliminary examination and search (Patents Form 9/77)	-
Request for substantive examination (Patents Form 10/77)	-
Any other documents (please specify)	-

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11. I/We request the grant of a patent on the basis of this application.

Signature  Date 31 October 2002  
Dr. J. Thompson

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12. Name and daytime telephone number of person to contact in the United Kingdom Dr. J. Thompson 01279 440172

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Signed *Andrew Gray*  
Dated 20 November 2003

### THERAPEUTIC AGENTS

The present invention relates to a class of substituted imidazo-pyridinone derivatives and to their use in therapy. More particularly, this 5 invention is concerned with imidazo[4,5-*c*]pyridin-4-one analogues which are substituted in the 1-position by a substituted phenyl ring. These compounds are ligands for GABA<sub>A</sub> receptors and are therefore useful in the therapy of adverse neurological disorders.

Receptors for the major inhibitory neurotransmitter, gamma-10 aminobutyric acid (GABA), are divided into two main classes: (1) GABA<sub>A</sub> receptors, which are members of the ligand-gated ion channel superfamily; and (2) GABA<sub>B</sub> receptors, which may be members of the G-protein linked receptor superfamily. Since the first cDNAs encoding individual GABA<sub>A</sub> receptor subunits were cloned the number of known members of the 15 mammalian family has grown to include at least six  $\alpha$  subunits, four  $\beta$  subunits, three  $\gamma$  subunits, one  $\delta$  subunit, one  $\varepsilon$  subunit and two  $\rho$  subunits.

Although knowledge of the diversity of the GABA<sub>A</sub> receptor gene 20 family represents a huge step forward in our understanding of this ligand-gated ion channel, insight into the extent of subtype diversity is still at an early stage. It has been indicated that an  $\alpha$  subunit, a  $\beta$  subunit and a  $\gamma$  subunit constitute the minimum requirement for forming a fully 25 functional GABA<sub>A</sub> receptor expressed by transiently transfecting cDNAs into cells. As indicated above,  $\delta$ ,  $\varepsilon$  and  $\rho$  subunits also exist, but are present only to a minor extent in GABA<sub>A</sub> receptor populations.

Studies of receptor size and visualisation by electron microscopy 30 conclude that, like other members of the ligand-gated ion channel family, the native GABA<sub>A</sub> receptor exists in pentameric form. The selection of at least one  $\alpha$ , one  $\beta$  and one  $\gamma$  subunit from a repertoire of seventeen allows for the possible existence of more than 10,000 pentameric subunit combinations. Moreover, this calculation overlooks the additional

permutations that would be possible if the arrangement of subunits around the ion channel had no constraints (i.e. there could be 120 possible variants for a receptor composed of five different subunits).

Receptor subtype assemblies which do exist include, amongst many  
5 others,  $\alpha 1\beta 2\gamma 2$ ,  $\alpha 2\beta \gamma 1$ ,  $\alpha 2\beta 2/3\gamma 2$ ,  $\alpha 3\beta \gamma 2/3$ ,  $\alpha 4\beta \delta$ ,  $\alpha 5\beta 3\gamma 2/3$ ,  $\alpha 6\beta \gamma 2$  and  $\alpha 6\beta \delta$ .  
Subtype assemblies containing an  $\alpha 1$  subunit are present in most areas of  
the brain and are thought to account for over 40% of GABA<sub>A</sub> receptors in  
the rat. Subtype assemblies containing  $\alpha 2$  and  $\alpha 3$  subunits respectively  
are thought to account for about 25% and 17% of GABA<sub>A</sub> receptors in the  
10 rat. Subtype assemblies containing an  $\alpha 5$  subunit are expressed  
predominantly in the hippocampus and cortex and are thought to  
represent about 4% of GABA<sub>A</sub> receptors in the rat.

A characteristic property of all known GABA<sub>A</sub> receptors is the  
presence of a number of modulatory sites, one of which is the  
15 benzodiazepine (BZ) binding site. The BZ binding site is the most explored  
of the GABA<sub>A</sub> receptor modulatory sites, and is the site through which  
anxiolytic drugs such as diazepam and temazepam exert their effect.  
Before the cloning of the GABA<sub>A</sub> receptor gene family, the benzodiazepine  
binding site was historically subdivided into two subtypes, BZ1 and BZ2,  
20 on the basis of radioligand binding studies. The BZ1 subtype has been  
shown to be pharmacologically equivalent to a GABA<sub>A</sub> receptor comprising  
the  $\alpha 1$  subunit in combination with a  $\beta$  subunit and  $\gamma 2$ . This is the most  
abundant GABA<sub>A</sub> receptor subtype, and is believed to represent almost  
half of all GABA<sub>A</sub> receptors in the brain.

25 Two other major populations are the  $\alpha 2\beta \gamma 2$  and  $\alpha 3\beta \gamma 2/3$  subtypes.  
Together these constitute approximately a further 35% of the total GABA<sub>A</sub>  
receptor repertoire. Pharmacologically this combination appears to be  
equivalent to the BZ2 subtype as defined previously by radioligand  
binding, although the BZ2 subtype may also include certain  $\alpha 5$ -containing  
30 subtype assemblies. The physiological role of these subtypes has hitherto

been unclear because no sufficiently selective agonists or antagonists were known.

It is now believed that agents acting as BZ agonists at  $\alpha 1\beta\gamma 2$ ,  $\alpha 2\beta\gamma 2$  or  $\alpha 3\beta\gamma 2$  subtypes will possess desirable anxiolytic properties. Compounds 5 which are modulators of the benzodiazepine binding site of the GABA<sub>A</sub> receptor by acting as BZ agonists are referred to hereinafter as "GABA<sub>A</sub> receptor agonists". The  $\alpha 1$ -selective GABA<sub>A</sub> receptor agonists alpidem and zolpidem are clinically prescribed as hypnotic agents, suggesting that at least some of the sedation associated with known anxiolytic drugs which 10 act at the BZ1 binding site is mediated through GABA<sub>A</sub> receptors containing the  $\alpha 1$  subunit. Accordingly, it is considered that GABA<sub>A</sub> receptor agonists which interact more favourably with the  $\alpha 2$  and/or  $\alpha 3$  subunit than with  $\alpha 1$  will be effective in the treatment of anxiety with a reduced propensity to cause sedation. Moreover, agents which are inverse 15 agonists of the  $\alpha 5$  subunit are likely to be beneficial in enhancing cognition, for example in subjects suffering from dementing conditions such as Alzheimer's disease. Also, agents which are antagonists or inverse agonists at  $\alpha 1$  might be employed to reverse sedation or hypnosis caused by  $\alpha 1$  agonists.

20 The compounds of the present invention, being selective ligands for GABA<sub>A</sub> receptors, are therefore of use in the treatment and/or prevention of a variety of disorders of the central nervous system. Such disorders include anxiety disorders, such as panic disorder with or without agoraphobia, agoraphobia without history of panic disorder, animal and 25 other phobias including social phobias, obsessive-compulsive disorder, stress disorders including post-traumatic and acute stress disorder, and generalized or substance-induced anxiety disorder; neuroses; convulsions; migraine; depressive or bipolar disorders, for example single-episode or recurrent major depressive disorder, dysthymic disorder, bipolar I and 30 bipolar II manic disorders, and cyclothymic disorder; psychotic disorders including schizophrenia; neurodegeneration arising from cerebral

ischemia; attention deficit hyperactivity disorder; Tourette's syndrome; speech disorders, including stuttering; and disorders of circadian rhythm, e.g. in subjects suffering from the effects of jet lag or shift work.

Further disorders for which selective ligands for GABA<sub>A</sub> receptors 5 may be of benefit include pain and nociception; emesis, including acute, delayed and anticipatory emesis, in particular emesis induced by chemotherapy or radiation, as well as motion sickness, and post-operative nausea and vomiting; eating disorders including anorexia nervosa and bulimia nervosa; premenstrual syndrome; muscle spasm or spasticity, e.g. 10 in paraplegic patients; hearing disorders, including tinnitus and age-related hearing impairment; urinary incontinence; and the effects of substance abuse or dependency, including alcohol withdrawal. Selective ligands for GABA<sub>A</sub> receptors may be beneficial in enhancing cognition, for example in subjects suffering from dementing conditions such as 15 Alzheimer's disease; and may also be effective as pre-medication prior to anaesthesia or minor procedures such as endoscopy, including gastric endoscopy.

In addition, the compounds in accordance with the present 20 invention may be useful as radioligands in assays for detecting compounds capable of binding to the human GABA<sub>A</sub> receptor.

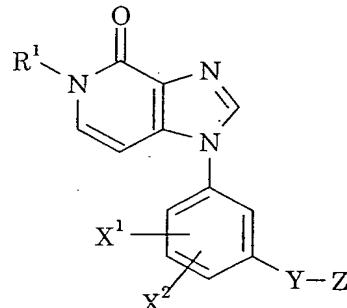
The present invention provides a class of imidazo-pyridinone derivatives which possess desirable binding properties at various GABA<sub>A</sub> receptor subtypes. The compounds in accordance with the present invention have good affinity as ligands for the  $\alpha$ 2 and/or  $\alpha$ 3 and/or  $\alpha$ 5 25 subunit of the human GABA<sub>A</sub> receptor. The compounds of this invention may interact more favourably with the  $\alpha$ 2 and/or  $\alpha$ 3 subunit than with the  $\alpha$ 1 subunit; and/or may interact more favourably with the  $\alpha$ 5 subunit than with the  $\alpha$ 1 subunit.

The compounds of the present invention are GABA<sub>A</sub> receptor 30 subtype ligands having a binding affinity ( $K_i$ ) for the  $\alpha$ 2 and/or  $\alpha$ 3 and/or  $\alpha$ 5 subunit, as measured in the assay described hereinbelow, of 200 nM or

less, typically of 100 nM or less, and ideally of 20 nM or less. The compounds in accordance with this invention may possess at least a 2-fold, suitably at least a 5-fold, and advantageously at least a 10-fold, selective affinity for the  $\alpha 2$  and/or  $\alpha 3$  and/or  $\alpha 5$  subunit relative to the  $\alpha 1$  subunit.

5 However, compounds which are not selective in terms of their binding affinity for the  $\alpha 2$  and/or  $\alpha 3$  and/or  $\alpha 5$  subunit relative to the  $\alpha 1$  subunit are also encompassed within the scope of the present invention; such compounds will desirably exhibit functional selectivity in terms of zero or weak (positive or negative) efficacy at the  $\alpha 1$  subunit and (i) a full or  
10 partial agonist profile at the  $\alpha 2$  and/or  $\alpha 3$  subunit, and/or (ii) an inverse agonist profile at the  $\alpha 5$  subunit.

The present invention provides a compound of formula I, or a pharmaceutically acceptable salt thereof:



15

(I)

wherein

20  $X^1$  represents hydrogen, halogen,  $C_{1-6}$  alkyl, trifluoromethyl or  $C_{1-6}$  alkoxy;

$X^2$  represents hydrogen or halogen;

$Y$  represents a chemical bond, an oxygen atom, or a  $-NH-$  linkage;

$Z$  represents an optionally substituted aryl or heteroaryl group;

25  $R^1$  represents hydrocarbon, a heterocyclic group, trifluoromethyl,  $-SO_2R^a$ ,  $-SO_2NR^aR^b$ ,  $-COR^a$ ,  $-CO_2R^a$  or  $-CONR^aR^b$ ; and

R<sup>a</sup> and R<sup>b</sup> independently represent hydrogen, hydrocarbon or a heterocyclic group.

The aryl or heteroaryl group Z in the compounds of formula I above may be unsubstituted, or substituted by one or more substituents.

5      Typically, the group Z will be unsubstituted, or substituted by one or two substituents. Suitably, the group Z is unsubstituted or monosubstituted. Typical substituents on the group Z include halogen, cyano, nitro, C<sub>1-6</sub> alkyl, hydroxy, C<sub>1-6</sub> alkoxy, oxy, C<sub>1-6</sub> alkylsulphonyl, amino, aminocarbonyl, formyl, C<sub>2-6</sub> alkoxy carbonyl and -CR<sup>a</sup>=NOR<sup>b</sup>, wherein R<sup>a</sup> and R<sup>b</sup> are as defined above.

10     For use in medicine, the salts of the compounds of formula I will be pharmaceutically acceptable salts. Other salts may, however, be useful in the preparation of the compounds according to the invention or of their pharmaceutically acceptable salts. Suitable pharmaceutically acceptable salts of the compounds of this invention include acid addition salts which may, for example, be formed by mixing a solution of the compound according to the invention with a solution of a pharmaceutically acceptable acid such as hydrochloric acid, sulphuric acid, methanesulphonic acid, fumaric acid, maleic acid, succinic acid, acetic acid, benzoic acid, oxalic acid, citric acid, tartaric acid, carbonic acid or phosphoric acid.

15     Furthermore, where the compounds of the invention carry an acidic moiety, suitable pharmaceutically acceptable salts thereof may include alkali metal salts, e.g. sodium or potassium salts; alkaline earth metal salts, e.g. calcium or magnesium salts; and salts formed with suitable organic ligands, e.g. quaternary ammonium salts.

20     The term "hydrocarbon" as used herein includes straight-chained, branched and cyclic groups containing up to 18 carbon atoms, suitably up to 15 carbon atoms, and conveniently up to 12 carbon atoms. Suitable hydrocarbon groups include C<sub>1-6</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>2-6</sub> alkynyl, C<sub>3-7</sub> cycloalkyl, C<sub>3-7</sub> cycloalkyl(C<sub>1-6</sub>)alkyl, indanyl, aryl and aryl(C<sub>1-6</sub>)alkyl.

The expression "a heterocyclic group" as used herein includes cyclic groups containing up to 18 carbon atoms and at least one heteroatom preferably selected from oxygen, nitrogen and sulphur. The heterocyclic group suitably contains up to 15 carbon atoms and conveniently up to 12 carbon atoms, and is preferably linked through carbon. Examples of suitable heterocyclic groups include C<sub>3-7</sub> heterocycloalkyl, C<sub>3-7</sub> heterocycloalkyl(C<sub>1-6</sub>)alkyl, heteroaryl and heteroaryl(C<sub>1-6</sub>)alkyl groups.

Suitable alkyl groups include straight-chained and branched alkyl groups containing from 1 to 6 carbon atoms. Typical examples include 10 methyl and ethyl groups, and straight-chained or branched propyl, butyl and pentyl groups. Particular alkyl groups are methyl, ethyl, *n*-propyl, isopropyl, isobutyl, *tert*-butyl and 2,2-dimethylpropyl. Derived expressions such as "C<sub>1-6</sub> alkoxy", "C<sub>1-6</sub> alkylamino" and "C<sub>1-6</sub> alkylsulphonyl" are to be construed accordingly.

15 Suitable alkenyl groups include straight-chained and branched alkenyl groups containing from 2 to 6 carbon atoms. Typical examples include vinyl, allyl and dimethylallyl groups.

20 Suitable alkynyl groups include straight-chained and branched alkynyl groups containing from 2 to 6 carbon atoms. Typical examples include ethynyl and propargyl groups.

Suitable cycloalkyl groups include groups containing from 3 to 7 carbon atoms. Particular cycloalkyl groups are cyclopropyl and cyclohexyl.

Typical examples of C<sub>3-7</sub> cycloalkyl(C<sub>1-6</sub>)alkyl groups include cyclopropylmethyl, cyclohexylmethyl and cyclohexylethyl.

25 Particular indanyl groups include indan-1-yl and indan-2-yl.

Particular aryl groups include phenyl and naphthyl, preferably phenyl.

Particular aryl(C<sub>1-6</sub>)alkyl groups include benzyl, phenylethyl, phenylpropyl and naphthylmethyl.

30 Suitable heterocycloalkyl groups include azetidinyl, pyrrolidinyl, piperidinyl, piperazinyl, morpholinyl and thiomorpholinyl groups.

5 Suitable heteroaryl groups include pyridinyl, quinolinyl, isoquinolinyl, pyridazinyl, pyrimidinyl, pyrazinyl, furyl, benzofuryl, dibenzofuryl, thienyl, benzthienyl, pyrrolyl, indolyl, pyrazolyl, indazolyl, oxazolyl, isoxazolyl, thiazolyl, isothiazolyl, imidazolyl, benzimidazolyl, oxadiazolyl, thiadiazolyl, triazolyl and tetrazolyl groups.

10 The expression "heteroaryl(C<sub>1-6</sub>)alkyl" as used herein includes furylmethyl, furylethyl, thienylmethyl, thienylethyl, oxazolylmethyl, oxazolylethyl, thiazolylmethyl, thiazolylethyl, imidazolylmethyl, imidazolylethyl, oxadiazolylmethyl, oxadiazolylethyl, thiadiazolylmethyl, thiadiazolylethyl, triazolylmethyl, triazolylethyl, tetrazolylmethyl, tetrazolylethyl, pyridinylmethyl, pyridinylethyl, pyrimidinylmethyl, pyrazinylmethyl, quinolinylmethyl and isoquinolinylmethyl.

15 The hydrocarbon and heterocyclic groups may in turn be optionally substituted by one or more groups selected from C<sub>1-6</sub> alkyl, adamantyl, phenyl, halogen, C<sub>1-6</sub> haloalkyl, C<sub>1-6</sub> aminoalkyl, trifluoromethyl, hydroxy, C<sub>1-6</sub> alkoxy, aryloxy, keto, C<sub>1-3</sub> alkylenedioxy, nitro, cyano, carboxy, C<sub>2-6</sub> alkoxycarbonyl, C<sub>2-6</sub> alkoxycarbonyl(C<sub>1-6</sub>)alkyl, C<sub>2-6</sub> alkylcarbonyloxy, arylcarbonyloxy, aminocarbonyloxy, C<sub>2-6</sub> alkylcarbonyl, arylcarbonyl, C<sub>1-6</sub> alkylthio, C<sub>1-6</sub> alkylsulphinyl, C<sub>1-6</sub> alkylsulphonyl, arylsulphonyl, -NR<sup>v</sup>R<sup>w</sup>, 20 -NR<sup>v</sup>COR<sup>w</sup>, -NR<sup>v</sup>CO<sub>2</sub>R<sup>w</sup>, -NR<sup>v</sup>SO<sub>2</sub>R<sup>w</sup>, -CH<sub>2</sub>NR<sup>v</sup>SO<sub>2</sub>R<sup>w</sup>, -NHCONR<sup>v</sup>R<sup>w</sup>, -CONR<sup>v</sup>R<sup>w</sup>, -SO<sub>2</sub>NR<sup>v</sup>R<sup>w</sup> and -CH<sub>2</sub>SO<sub>2</sub>NR<sup>v</sup>R<sup>w</sup>, in which R<sup>v</sup> and R<sup>w</sup> independently represent hydrogen, C<sub>1-6</sub> alkyl, aryl or aryl(C<sub>1-6</sub>)alkyl.

25 The term "halogen" as used herein includes fluorine, chlorine, bromine and iodine, especially fluoro or chloro.

Where the compounds according to the invention have at least one asymmetric centre, they may accordingly exist as enantiomers. Where the compounds according to the invention possess two or more asymmetric centres, they may additionally exist as diastereoisomers. It is to be understood that all such isomers and mixtures thereof in any proportion 30 are encompassed within the scope of the present invention.

Suitable values for the X<sup>1</sup> substituent include hydrogen, fluoro, chloro, methyl, trifluoromethyl and methoxy; in particular hydrogen or fluoro; and especially fluoro.

Typical values of X<sup>2</sup> include hydrogen and fluoro, especially  
5 hydrogen.

In a preferred embodiment, Y represents a chemical bond.

In another embodiment, Y represents an oxygen atom.

In a further embodiment, Y represents a -NH- linkage.

Selected values for the substituent Z include phenyl, pyridinyl,  
10 pyridazinyl, pyrimidinyl, pyrazinyl, furyl, thienyl, oxazolyl, isoxazolyl, thiazolyl, isothiazolyl, pyrrolyl, pyrazolyl, imidazolyl, oxadiazolyl, thiadiazolyl, triazolyl and tetrazolyl, any of which groups may be optionally substituted by one or more substituents.

In one favoured embodiment, Z represents an optionally substituted phenyl group, in particular monosubstituted or disubstituted phenyl. In another favoured embodiment, Z represents optionally substituted pyridinyl, especially unsubstituted, monosubstituted or disubstituted pyridin-2-yl, pyridin-3-yl or pyridin-4-yl.

Examples of suitable substituents on the group Z include fluoro,  
20 chloro, cyano, nitro, methyl, hydroxy, methoxy, oxy, methanesulphonyl, amino, aminocarbonyl, formyl, methoxycarbonyl and -CH=NOH.

Examples of particular substituents on the group Z include fluoro and cyano.

Detailed values of Z include difluorophenyl, cyanophenyl,  
25 (cyano)(fluoro)phenyl, (chloro)(cyano)phenyl, nitrophenyl, methoxyphenyl, methanesulphonyl-phenyl, pyridinyl, fluoro-pyridinyl, difluoro-pyridinyl, (amino)(chloro)pyridinyl, cyano-pyridinyl, methyl-pyridinyl, hydroxy-pyridinyl, methoxy-pyridinyl, oxy-pyridinyl, aminocarbonyl-pyridinyl, pyridazinyl, pyrimidinyl, pyrazinyl, cyano-thienyl, aminocarbonyl-thienyl, 30 formyl-thienyl, methoxycarbonyl-thienyl, thienyl-CH=NOH, thiazolyl,

isothiazolyl, pyrrolyl, pyrazolyl, imidazolyl, triazolyl and methyltetrazolyl.

Specific values of Z include difluorophenyl, cyanophenyl, (cyano)(fluoro)phenyl, pyridinyl and fluoro-pyridinyl.

5 In one embodiment, Z represents (cyano)(fluoro)phenyl, especially 2-cyano-5-fluorophenyl.

Typically, R<sup>1</sup> represents hydrocarbon, a heterocyclic group, trifluoromethyl, -COR<sup>a</sup> or -CO<sub>2</sub>R<sup>a</sup>.

10 Typical values of R<sup>a</sup> include hydrogen and C<sub>1-6</sub> alkyl. Suitably, R<sup>a</sup> represents hydrogen or methyl.

Typical values of R<sup>b</sup> include hydrogen, C<sub>1-6</sub> alkyl, hydroxy(C<sub>1-6</sub>)alkyl and di(C<sub>1-6</sub>)alkylamino(C<sub>1-6</sub>)alkyl. Suitably, R<sup>b</sup> represents hydrogen, methyl, ethyl, hydroxyethyl or dimethylaminoethyl. Particular values of R<sup>b</sup> include hydrogen, hydroxyethyl and dimethylaminoethyl, especially 15 hydrogen or dimethylaminoethyl.

Suitable values of R<sup>1</sup> include C<sub>1-6</sub> alkyl, halo(C<sub>1-6</sub>)alkyl, dihalo(C<sub>1-6</sub>)alkyl, hydroxy(C<sub>1-6</sub>)alkyl, dihydroxy(C<sub>1-6</sub>)alkyl, C<sub>1-6</sub> alkoxy(C<sub>1-6</sub>)alkyl, di(C<sub>1-6</sub>)alkoxy(C<sub>1-6</sub>)alkyl, cyano(C<sub>1-6</sub>)alkyl, C<sub>2-6</sub> 20 alkoxy carbonyl(C<sub>1-6</sub>)alkyl, C<sub>3-7</sub> cycloalkyl, heteroaryl, C<sub>1-6</sub> alkyl-heteroaryl, heteroaryl(C<sub>1-6</sub>)alkyl, trifluoromethyl, formyl, C<sub>2-6</sub> alkylcarbonyl and C<sub>2-6</sub> alkoxy carbonyl.

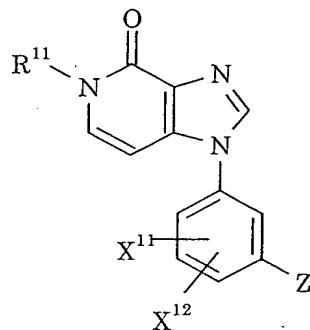
Representative values of R<sup>1</sup> include C<sub>1-6</sub> alkyl, halo(C<sub>1-6</sub>)alkyl, hydroxy(C<sub>1-6</sub>)alkyl and trifluoromethyl.

Individual values of R<sup>1</sup> include methyl, fluoromethyl, 25 difluoromethyl, hydroxymethyl, methoxymethyl, dimethoxymethyl, hydroxyethyl (especially 1-hydroxyethyl), fluoroethyl (especially 1-fluoroethyl), difluoroethyl (especially 1,1-difluoroethyl), dimethoxyethyl (especially 1,1-dimethoxyethyl), isopropyl, hydroxypropyl (especially 2-hydroxyprop-2-yl), dihydroxypropyl (especially 1,2-dihydroxyprop-2-yl), 30 fluoropropyl (especially 2-fluoroprop-2-yl), cyanopropyl (especially 2-cyanoprop-2-yl), methoxycarbonylpropyl (especially 2-

methoxycarbonylprop-2-yl), *tert*-butyl, hydroxybutyl (especially 1-hydroxy-2-methylprop-2-yl), cyclopropyl, pyridinyl, furyl, thieryl, oxazolyl, methylthiazolyl, methyloxadiazolyl, imidazolylmethyl, triazolylmethyl, trifluoromethyl, formyl, acetyl and methoxycarbonyl.

5 In a favoured embodiment, R<sup>1</sup> represents 2-hydroxyprop-2-yl. In another embodiment, R<sup>1</sup> represents 2-fluoroprop-2-yl. In an additional embodiment, R<sup>1</sup> represents trifluoromethyl. In a further embodiment, R<sup>1</sup> represents methyl.

10 A particular sub-class of compounds according to the invention is represented by the compounds of formula IIA, and pharmaceutically acceptable salts thereof:



(IIA)

15 wherein

Z is as defined above;

X<sup>11</sup> represents hydrogen, fluoro, chloro, methyl, trifluoromethyl or methoxy;

X<sup>12</sup> represents hydrogen or fluoro; and

20 R<sup>11</sup> represents C<sub>1-6</sub> alkyl, halo(C<sub>1-6</sub>)alkyl, dihalo(C<sub>1-6</sub>)alkyl, hydroxy(C<sub>1-6</sub>)alkyl, dihydroxy(C<sub>1-6</sub>)alkyl, C<sub>1-6</sub> alkoxy(C<sub>1-6</sub>)alkyl, di(C<sub>1-6</sub>)alkoxy(C<sub>1-6</sub>)alkyl, cyano(C<sub>1-6</sub>)alkyl, C<sub>2-6</sub> alkoxycarbonyl(C<sub>1-6</sub>)alkyl, C<sub>3-7</sub> cycloalkyl, heteroaryl, C<sub>1-6</sub> alkyl-heteroaryl, heteroaryl(C<sub>1-6</sub>)alkyl, trifluoromethyl, formyl, C<sub>2-6</sub> alkylcarbonyl or C<sub>2-6</sub> alkoxycarbonyl.

25 Suitable values of X<sup>11</sup> include hydrogen and fluoro, especially fluoro.

In a favoured embodiment,  $X^{12}$  represents hydrogen. In another embodiment,  $X^{12}$  represents fluoro.

Where  $R^{11}$  represents heteroaryl, this group is suitably pyridinyl, furyl, thienyl or oxazolyl.

5 Where  $R^{11}$  represents  $C_{1-6}$  alkyl-heteroaryl, this group is suitably methylthiazolyl (e.g. 2-methylthiazol-5-yl) or methyloxadiazolyl (e.g. 3-methyl-[1,2,4]oxadiazol-5-yl).

Where  $R^{11}$  represents heteroaryl( $C_{1-6}$ )alkyl, this group is suitably imidazolylmethyl or triazolylmethyl.

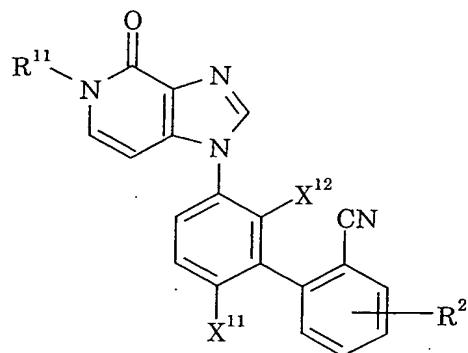
10 Representative values of  $R^{11}$  include  $C_{1-6}$  alkyl, hydroxy( $C_{1-6}$ )alkyl, fluoro( $C_{1-6}$ )alkyl and trifluoromethyl.

Individual values of  $R^{11}$  include methyl, fluoromethyl, difluoromethyl, hydroxymethyl, methoxymethyl, dimethoxymethyl, hydroxyethyl (especially 1-hydroxyethyl), fluoroethyl (especially 1-fluoroethyl), difluoroethyl (especially 1,1-difluoroethyl), dimethoxyethyl (especially 1,1-dimethoxyethyl), isopropyl, hydroxypropyl (especially 2-hydroxyprop-2-yl), dihydroxypropyl (especially 1,2-dihydroxyprop-2-yl), fluoropropyl (especially 2-fluoroprop-2-yl), cyanopropyl (especially 2-cyanoprop-2-yl), methoxycarbonylpropyl (especially 2-methoxycarbonylprop-2-yl), *tert*-butyl, hydroxybutyl (especially 1-hydroxy-2-methylprop-2-yl), cyclopropyl, pyridinyl, furyl, thienyl, oxazolyl, methylthiazolyl, methyloxadiazolyl, imidazolylmethyl, triazolylmethyl, trifluoromethyl, formyl, acetyl and methoxycarbonyl.

25 In a favoured embodiment,  $R^{11}$  represents 2-hydroxyprop-2-yl. In another embodiment,  $R^{11}$  represents 2-fluoroprop-2-yl. In an additional embodiment,  $R^{11}$  represents trifluoromethyl. In a further embodiment,  $R^{11}$  represents methyl.

One representative subset of the compounds of formula IIA above is represented by the compounds of formula IIB, and pharmaceutically acceptable salts thereof.

30



(IIB)

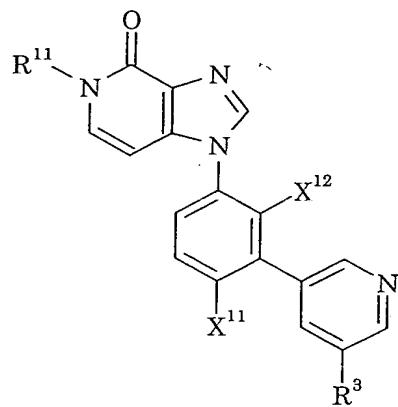
wherein X¹¹, X¹² and R¹¹ are as defined above; and

R² represents hydrogen or fluoro.

5 In one embodiment, R² is hydrogen.

In another embodiment, R² is fluoro, in which case the fluorine atom R² is favourably attached to the phenyl ring at the 4-, 5- or 6-position (relative to the cyano group at position 2).

10 Another representative subset of the compounds of formula IIA above is represented by the compounds of formula IIC, and pharmaceutically acceptable salts thereof:



(IIC)

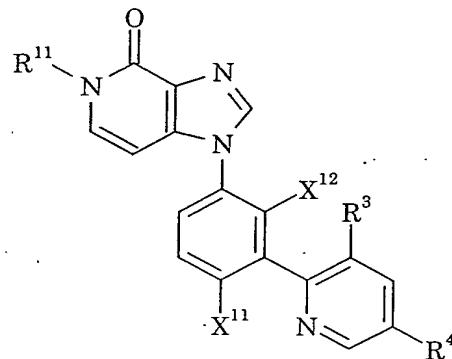
15 wherein X¹¹, X¹² and R¹¹ are as defined above; and

R³ represents hydrogen or fluoro.

In one embodiment, R<sup>3</sup> is hydrogen.

In another embodiment, R<sup>3</sup> is fluoro.

A further representative subset of the compounds of formula IIA above is represented by the compounds of formula IID, and  
5 pharmaceutically acceptable salts thereof:



(IID)

wherein X<sup>11</sup>, X<sup>12</sup>, R<sup>3</sup> and R<sup>11</sup> are as defined above; and

10 R<sup>4</sup> represents hydrogen or fluoro.

Suitably, R<sup>4</sup> represents hydrogen.

In another embodiment, R<sup>4</sup> represents fluoro.

Specific compounds within the scope of the present invention include:

15 3'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-c]pyridin-1-yl)biphenyl-2-carbonitrile;

1-[4-fluoro-3-(5-fluoropyridin-3-yl)phenyl]-5-methyl-1,5-dihydroimidazo[4,5-c]pyridin-4-one;

5,2'-difluoro-5'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-c]pyridin-1-yl)-20 biphenyl-2-carbonitrile;

1-[4-fluoro-3-(pyridin-3-yl)phenyl]-5-methyl-1,5-dihydroimidazo[4,5-c]pyridin-4-one;

5-methyl-1-(2,2',3'-trifluorobiphenyl-5-yl)-1,5-dihydroimidazo[4,5-c]pyridin-4-one;

4,2'-difluoro-5'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-c]pyridin-1-yl)biphenyl-2-carbonitrile;

5 and pharmaceutically acceptable salts thereof.

Also provided by the present invention is a method for the treatment and/or prevention of anxiety which comprises administering to a patient in need of such treatment an effective amount of a compound of formula I as defined above or a pharmaceutically acceptable salt thereof.

10 Further provided by the present invention is a method for the treatment and/or prevention of convulsions (e.g. in a patient suffering from epilepsy or a related disorder) which comprises administering to a patient in need of such treatment an effective amount of a compound of formula I as defined above or a pharmaceutically acceptable salt thereof.

15 The binding affinity ( $K_i$ ) of the compounds according to the present invention for the  $\alpha 3$  subunit of the human GABA<sub>A</sub> receptor is conveniently as measured in the assay described hereinbelow. The  $\alpha 3$  subunit binding affinity ( $K_i$ ) of the anxiolytic compounds of the invention is ideally 50 nM or less, preferably 10 nM or less, and more preferably 5 nM or less.

20 The anxiolytic compounds according to the present invention will ideally elicit at least a 40%, preferably at least a 50%, and more preferably at least a 60%, potentiation of the GABA EC<sub>20</sub> response in stably transfected recombinant cell lines expressing the  $\alpha 3$  subunit of the human GABA<sub>A</sub> receptor. Moreover, the compounds of the invention will ideally elicit at most a 30%, preferably at most a 20%, and more preferably at most a 10%, potentiation of the GABA EC<sub>20</sub> response in stably transfected recombinant cell lines expressing the  $\alpha 1$  subunit of the human GABA<sub>A</sub> receptor.

25 The potentiation of the GABA EC<sub>20</sub> response in stably transfected cell lines expressing the  $\alpha 3$  and  $\alpha 1$  subunits of the human GABA<sub>A</sub> receptor can conveniently be measured by procedures analogous to the protocol

described in Wafford *et al.*, *Mol. Pharmacol.*, 1996, **50**, 670-678. The procedure will suitably be carried out utilising cultures of stably transfected eukaryotic cells, typically of stably transfected mouse Ltk-fibroblast cells.

5 The compounds according to the present invention may exhibit anxiolytic activity, as may be demonstrated by a positive response in the elevated plus maze and conditioned suppression of drinking tests (cf. Dawson *et al.*, *Psychopharmacology*, 1995, **121**, 109-117). Moreover, the compounds of the invention are likely to be substantially non-sedating, as  
10 may be confirmed by an appropriate result obtained from the response sensitivity (chain-pulling) test (cf. Bayley *et al.*, *J. Psychopharmacol.*, 1996, **10**, 206-213).

The compounds according to the present invention may also exhibit anticonvulsant activity. This can be demonstrated by the ability to block  
15 pentylenetetrazole-induced seizures in rats and mice, following a protocol analogous to that described by Bristow *et al.* in *J. Pharmacol. Exp. Ther.*, 1996, **279**, 492-501.

In another aspect, the present invention provides a method for the treatment and/or prevention of cognitive disorders, including dementing  
20 conditions such as Alzheimer's disease, which comprises administering to a patient in need of such treatment an effective amount of a compound of formula I as defined above or a pharmaceutically acceptable salt thereof.

Cognition enhancement can be shown by testing the compounds in the Morris watermaze as reported by McNamara and Skelton, *Psychobiology*, 1993, **21**, 101-108. Further details of relevant methodology are described in WO 96/25948.

Cognitive disorders for which the compounds of the present invention may be of benefit include delirium, dementia, amnestic disorders, and cognition deficits, including age-related memory deficits,  
30 due to traumatic injury, stroke, Parkinson's disease and Down Syndrome. Any of these conditions may be attributable to substance abuse or

withdrawal. Examples of dementia include dementia of the Alzheimer's type with early or late onset, and vascular dementia, any of which may be uncomplicated or accompanied by delirium, delusions or depressed mood; and dementia due to HIV disease, head trauma, Parkinson's disease or

5 Creutzfeld-Jakob disease.

In order to elicit their behavioural effects, the compounds of the invention will ideally be brain-penetrant; in other words, these compounds will be capable of crossing the so-called "blood-brain barrier". Preferably, the compounds of the invention will be capable of exerting their beneficial

10 therapeutic action following administration by the oral route.

The invention also provides pharmaceutical compositions comprising one or more compounds of this invention in association with a pharmaceutically acceptable carrier. Preferably these compositions are in unit dosage forms such as tablets, pills, capsules, powders, granules,

15 sterile parenteral solutions or suspensions, metered aerosol or liquid

sprays, drops, ampoules, auto-injector devices or suppositories; for oral,

parenteral, intranasal, sublingual or rectal administration, or for

administration by inhalation or insufflation. For preparing solid

compositions such as tablets, the principal active ingredient is mixed with

20 a pharmaceutical carrier, e.g. conventional tableting ingredients such as

corn starch, lactose, sucrose, sorbitol, talc, stearic acid, magnesium

stearate, dicalcium phosphate or gums, and other pharmaceutical

diluents, e.g. water, to form a solid preformulation composition containing

a homogeneous mixture of a compound of the present invention, or a

25 pharmaceutically acceptable salt thereof. When referring to these

preformulation compositions as homogeneous, it is meant that the active

ingredient is dispersed evenly throughout the composition so that the

composition may be readily subdivided into equally effective unit dosage

forms such as tablets, pills and capsules. This solid preformulation

30 composition is then subdivided into unit dosage forms of the type described

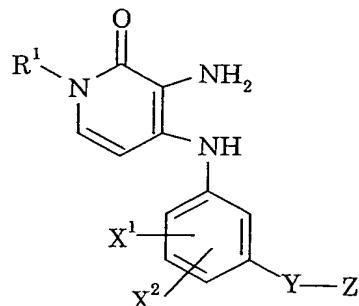
above containing from 0.1 to about 500 mg of the active ingredient of the

present invention. Typical unit dosage forms contain from 1 to 100 mg, for example 1, 2, 5, 10, 25, 50 or 100 mg, of the active ingredient. The tablets or pills of the novel composition can be coated or otherwise compounded to provide a dosage form affording the advantage of prolonged action. For 5 example, the tablet or pill can comprise an inner dosage and an outer dosage component, the latter being in the form of an envelope over the former. The two components can be separated by an enteric layer which serves to resist disintegration in the stomach and permits the inner component to pass intact into the duodenum or to be delayed in release. A 10 variety of materials can be used for such enteric layers or coatings, such materials including a number of polymeric acids and mixtures of polymeric acids with such materials as shellac, cetyl alcohol and cellulose acetate.

The liquid forms in which the novel compositions of the present invention may be incorporated for administration orally or by injection 15 include aqueous solutions, suitably flavoured syrups, aqueous or oil suspensions, and flavoured emulsions with edible oils such as cottonseed oil, sesame oil, coconut oil or peanut oil, as well as elixirs and similar pharmaceutical vehicles. Suitable dispersing or suspending agents for aqueous suspensions include synthetic and natural gums such as 20 tragacanth, acacia, alginate, dextran, sodium carboxymethylcellulose, methylcellulose, polyvinyl-pyrrolidone or gelatin.

In the treatment of neurological disorders, a suitable dosage level is about 0.01 to 250 mg/kg per day, preferably about 0.05 to 100 mg/kg per day, and especially about 0.05 to 5 mg/kg per day. The compounds may be 25 administered on a regimen of 1 to 4 times per day.

The compounds in accordance with the present invention may be prepared by a process which comprises reacting a compound of formula III:

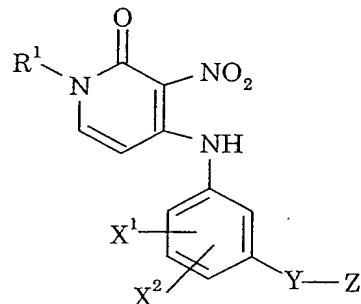


(III)

wherein X<sup>1</sup>, X<sup>2</sup>, Y, Z and R<sup>1</sup> are as defined above; with formic acid.

5 The reaction is conveniently accomplished by stirring the reactants at an elevated temperature, typically in the region of 95°C.

The intermediates of formula III may be prepared by reduction of a compound of formula IV:



(IV)

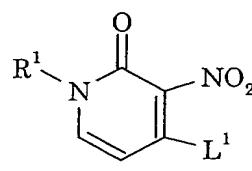
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wherein X<sup>1</sup>, X<sup>2</sup>, Y, Z and R<sup>1</sup> are as defined above.

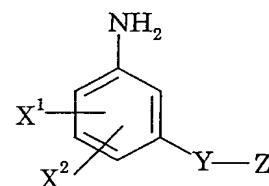
The reduction is conveniently effected by treating compound IV with hydrogen in the presence of a hydrogenation catalyst, e.g. platinum oxide, in a suitable solvent, for example a mixture of ethanol and ethyl acetate.

15

The intermediates of formula IV may be prepared by reacting a compound of formula V with a compound of formula VI:



(V)



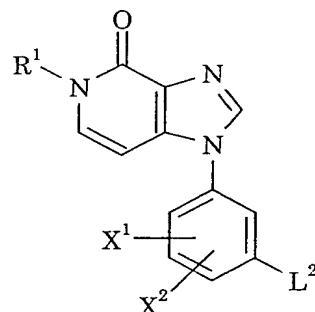
(VI)

wherein  $\text{X}^1$ ,  $\text{X}^2$ ,  $\text{Y}$ ,  $\text{Z}$  and  $\text{R}^1$  are as defined above, and  $\text{L}^1$  represents a suitable leaving group.

5 The leaving group  $\text{L}^1$  is typically a halogen atom, e.g. chloro.

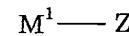
The reaction between compounds V and VI is conveniently effected by heating the reactants, to a temperature typically in the region of 90°C, in the presence of a base such as triethylamine, in a solvent such as dimethylsulfoxide.

10 In another procedure, the compounds according to the present invention in which  $\text{Y}$  represents a chemical bond may be prepared by a process which comprises reacting a compound of formula VII with a compound of formula VIII:



15

(VII)



(VIII)

wherein  $\text{X}^1$ ,  $\text{X}^2$ ,  $\text{Z}$  and  $\text{R}^1$  are as defined above,  $\text{L}^2$  represents a suitable leaving group, and  $\text{M}^1$  represents a boronic acid moiety  $-\text{B}(\text{OH})_2$  or a cyclic ester thereof formed with an organic diol, e.g. pinacol, 1,3-propanediol or

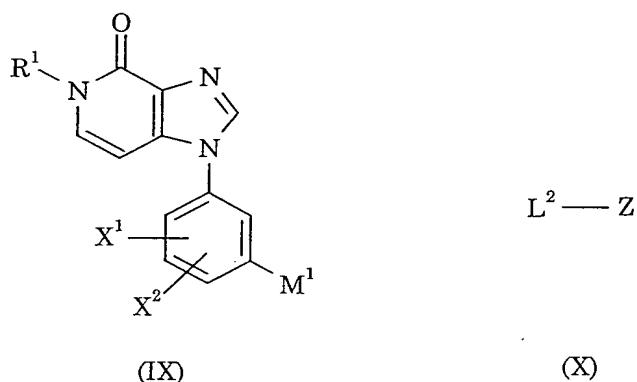
20 neopentyl glycol, or  $\text{M}^1$  represents  $-\text{Sn}(\text{Alk})_3$  in which  $\text{Alk}$  represents a  $\text{C}_{1-6}$

alkyl group, typically *n*-butyl; in the presence of a transition metal catalyst.

In the compounds of formula VII above, the leaving group  $L^2$  is typically trifluoromethanesulfonyloxy (triflyloxy); or a halogen atom, e.g. bromo.

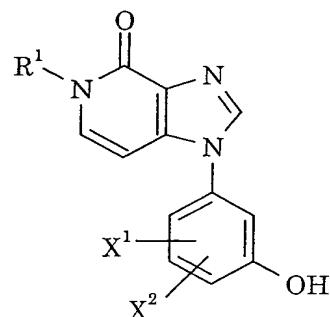
The transition metal catalyst of use in the reaction between compounds VII and VIII is suitably tetrakis(triphenylphosphine)-palladium(0). The reaction is conveniently carried out at an elevated temperature in a solvent such as *N,N*-dimethylacetamide, 1,2-dimethoxyethane, 1,4-dioxane or tetrahydrofuran, advantageously in the presence of potassium phosphate, copper(I) iodide, sodium carbonate or cesium carbonate. Alternatively, the transition metal catalyst employed may be tris(dibenzylideneacetone)dipalladium(0), in which case the reaction is conveniently effected at an elevated temperature in a solvent such as 1,4-dioxane, typically in the presence of tri-*tert*-butylphosphine and potassium phosphate.

Alternatively, the compounds according to the present invention in which Y represents a chemical bond may be prepared by a process which comprises reacting a compound of formula IX with a compound of formula X:



wherein  $X^1$ ,  $X^2$ ,  $Z$ ,  $R^1$ ,  $L^2$  and  $M^1$  are as defined above; in the presence of a transition metal catalyst; under conditions analogous to those described above for the reaction between compounds VII and VIII.

5 In an additional procedure, the compounds according to the present invention in which  $Y$  represents an oxygen atom may be prepared by a process which comprises reacting a compound of formula X as defined above with a compound of formula XI:



(XI)

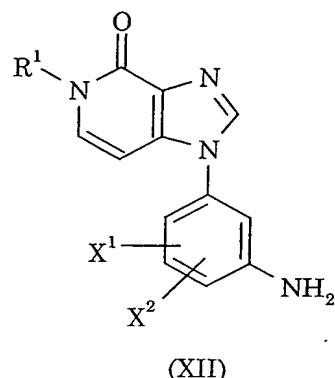
10

wherein  $X^1$ ,  $X^2$  and  $R^1$  are as defined above.

The reaction is conveniently carried out under basic conditions, e.g. using sodium hydride in a solvent such as *N,N*-dimethylformamide, typically at an elevated temperature which may be in the region of 120°C.

15

In a further procedure, the compounds according to the present invention in which  $Y$  represents a -NH- linkage may be prepared by a process which comprises reacting a compound of formula X as defined above with a compound of formula XII:



wherein X<sup>1</sup>, X<sup>2</sup> and R<sup>1</sup> are as defined above.

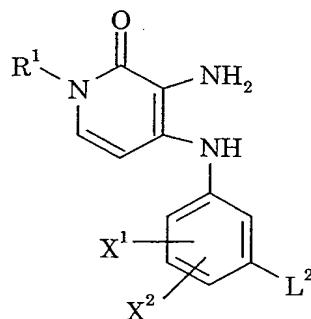
5 In relation to the reaction between compounds X and XII, the leaving group L<sup>2</sup> in the compounds of formula X may suitably represent fluoro.

The reaction between compounds X and XII is conveniently carried out by heating the reactants, typically at a temperature in the region of 120°C, in a solvent such as *N,N*-dimethylformamide.

10 Where M<sup>1</sup> in the intermediates of formula VIII and IX above represents a boronic acid moiety -B(OH)<sub>2</sub> or a cyclic ester thereof formed with pinacol or neopentyl glycol, the relevant compound VIII or IX may be prepared by reacting bis(pinacolato)diboron or bis(neopentyl glycolato)diborane respectively with a compound of formula X or VII as defined above; in the presence of a transition metal catalyst.

15 The transition metal catalyst of use in the reaction between bis(pinacolato)diboron or bis(neopentyl glycolato)diborane and compound X or VII is suitably dichloro[1,1'-bis(diphenylphosphino)ferrocene]-palladium(II). The reaction is conveniently carried out at an elevated 20 temperature in a solvent such as 1,4-dioxane, optionally in admixture with dimethylsulfoxide, typically in the presence of 1,1'-bis(diphenylphosphino)ferrocene and/or potassium acetate.

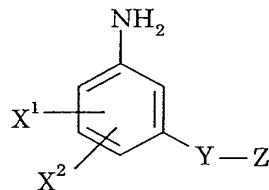
The intermediates of formula VII above may be prepared by reacting a compound of formula XIII:



(XIII)

wherein X<sup>1</sup>, X<sup>2</sup>, R<sup>1</sup> and L<sup>2</sup> are as defined above; with formic acid; under conditions analogous to those described above for the reaction between  
5 compound III and formic acid.

The intermediates of formula XIII may be prepared by reaction of a compound of formula V as defined above with a compound of formula XIV:

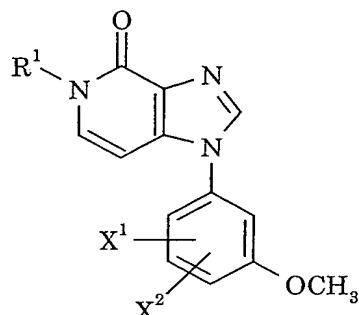


(XIV)

10 wherein X<sup>1</sup>, X<sup>2</sup>, Y and Z are as defined above; under conditions analogous to those described above for the reaction between compounds V and VI; followed by reduction of the nitro group in the resulting compound, under conditions analogous to those described above for the reduction of the nitro  
15 group in compound IV.

Where L<sup>2</sup> in the intermediates of formula VII above represents triflyloxy, the relevant compound VII may be prepared by reacting the appropriate compound of formula XI as defined above with triflic anhydride, typically in the presence of pyridine.

20 The intermediates of formula XI above may suitably be prepared from the appropriate methoxy-substituted precursor of formula XV:

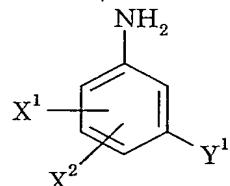


(XV)

wherein X<sup>1</sup>, X<sup>2</sup> and R<sup>1</sup> are as defined above; by treatment with boron 5 tribromide, typically in chloroform or dichloromethane; or with hydrogen bromide, typically in acetic acid at reflux.

The intermediates of formula XII and XV above may be prepared by reacting a compound of formula V as defined above with the appropriate compound of formula XVI:

10



(XVI)

wherein X<sup>1</sup> and X<sup>2</sup> are as defined above, and Y<sup>1</sup> represents amino or 15 methoxy; under conditions analogous to those described above for the reaction between compounds V and VI; followed by reduction of the nitro group in the resulting compound, under conditions analogous to those described above for the reduction of the nitro group in compound IV; followed by reaction of the product thereby obtained with formic acid, under conditions analogous to those described above for the reaction 20 between compound III and formic acid.

The compounds according to the invention in which Y represents a chemical bond and Z represents pyrrol-1-yl may be prepared by reacting a compound of formula XII as defined above with 2,5-dimethoxytetrahydrofuran. The reaction is conveniently accomplished at an elevated 5 temperature in a solvent such as acetic acid.

Where they are not commercially available, the starting materials of formula V, VI, X, XIV and XVI may be prepared by methods analogous to those described in the accompanying Examples, or by standard methods well known from the art.

10 It will be understood that any compound of formula I initially obtained from any of the above processes may, where appropriate, subsequently be elaborated into a further compound of formula I by techniques known from the art. For example, a compound of formula I wherein R<sup>1</sup> represents -C(O-Alk<sup>1</sup>)<sub>2</sub>R<sup>a</sup> initially obtained, wherein Alk<sup>1</sup> is C<sub>1-6</sub> alkyl, typically methyl or ethyl, may be converted into the 15 corresponding compound of formula I wherein R<sup>1</sup> represents -COR<sup>a</sup> by hydrolysis with a mineral acid, typically aqueous hydrochloric acid. A compound wherein R<sup>1</sup> represents formyl may be reduced with sodium triacetoxyborohydride to the corresponding compound wherein R<sup>1</sup> represents hydroxymethyl. A compound of formula I wherein R<sup>1</sup> represents hydroxymethyl 20 may be reduced with lithium aluminium hydride to the corresponding compound of formula I wherein R<sup>1</sup> represents hydroxymethyl. A compound of formula I wherein R<sup>1</sup> represents hydroxymethyl may be oxidised to the corresponding compound of formula 25 I wherein R<sup>1</sup> represents formyl by treatment with manganese dioxide. Alternatively, the compound of formula I wherein R<sup>1</sup> represents formyl 30 may be reacted with a Grignard reagent of formula R<sup>a</sup>MgBr to afford a compound of formula I wherein R<sup>1</sup> represents -CH(OH)R<sup>a</sup>, and this compound may in turn be oxidised using manganese dioxide to the corresponding compound of formula I wherein R<sup>1</sup> represents -COR<sup>a</sup>. A compound of formula I wherein R<sup>1</sup> represents -CH(OH)R<sup>a</sup> may be

converted into the corresponding compound of formula I wherein R<sup>1</sup> represents -CHFR<sup>a</sup> by treatment with (diethylamino)sulfur trifluoride (DAST). Similarly, a compound of formula I wherein R<sup>1</sup> represents -COR<sup>a</sup> may be converted into the corresponding compound of formula I wherein 5 R<sup>1</sup> represents -CF<sub>2</sub>R<sup>a</sup> by treatment with DAST. A compound of formula I wherein R<sup>1</sup> represents -COCH<sub>3</sub> may be treated with thioacetamide in the presence of pyridinium tribromide to furnish the corresponding compound of formula I wherein R<sup>1</sup> represents 2-methylthiazol-5-yl. Moreover, a compound of formula I wherein R<sup>1</sup> is formyl may be treated with (p-tolylsulfonyl)methyl isocyanide (TosMIC) in the presence of potassium 10 carbonate to afford the corresponding compound of formula I wherein R<sup>1</sup> represents oxazol-5-yl. A compound of formula I wherein R<sup>1</sup> represents hydroxymethyl may be treated with carbon tetrabromide and triphenylphosphine to afford the corresponding compound of formula I 15 wherein R<sup>1</sup> represents bromomethyl, which may then be reacted (typically *in situ*) with the sodium salt of imidazole or 1*H*-[1,2,4]triazole to provide a compound of formula I wherein R<sup>1</sup> represents imidazol-1-ylmethyl or [1,2,4]triazol-1-ylmethyl respectively; or with the sodium salt of 1*H*-[1,2,3]triazole to provide a mixture of compounds of formula I wherein R<sup>1</sup> 20 represents [1,2,3]triazol-1-ylmethyl and [1,2,3]triazol-2-ylmethyl; or with morpholine to provide a compound of formula I wherein R<sup>1</sup> represents morpholin-4-ylmethyl. A compound of formula I wherein Z is substituted with methoxy may be converted to the corresponding compound wherein Z is substituted with hydroxy by treatment with boron tribromide. 25

Where a mixture of products is obtained from any of the processes described above for the preparation of compounds according to the invention, the desired product can be separated therefrom at an appropriate stage by conventional methods such as preparative HPLC; or column chromatography utilising, for example, silica and/or alumina in 30 conjunction with an appropriate solvent system.

Where the above-described processes for the preparation of the compounds according to the invention give rise to mixtures of stereoisomers, these isomers may be separated by conventional techniques such as preparative chromatography. The novel compounds may be 5 prepared in racemic form, or individual enantiomers may be prepared either by enantiospecific synthesis or by resolution. The novel compounds may, for example, be resolved into their component enantiomers by standard techniques such as preparative HPLC, or the formation of diastereomeric pairs by salt formation with an optically active acid, such 10 as (-)-di-*p*-toluoyl-d-tartaric acid and/or (+)-di-*p*-toluoyl-l-tartaric acid, followed by fractional crystallization and regeneration of the free base. The novel compounds may also be resolved by formation of diastereomeric esters or amides, followed by chromatographic separation and removal of 15 the chiral auxiliary.

15 During any of the above synthetic sequences it may be necessary and/or desirable to protect sensitive or reactive groups on any of the molecules concerned. This may be achieved by means of conventional protecting groups, such as those described in *Protective Groups in Organic Chemistry*, ed. J.F.W. McOmie, Plenum Press, 1973; and T.W. Greene & 20 P.G.M. Wuts, *Protective Groups in Organic Synthesis*, John Wiley & Sons, 3rd edition, 1999. The protecting groups may be removed at a convenient subsequent stage using methods known from the art.

The following Examples illustrate the preparation of compounds according to the invention.

25 The compounds in accordance with this invention potently inhibit the binding of [<sup>3</sup>H]-flumazenil to the benzodiazepine binding site of human GABA<sub>A</sub> receptors containing the  $\alpha$ 2 and/or  $\alpha$ 3 and/or  $\alpha$ 5 subunit stably expressed in Ltk<sup>-</sup> cells.

30 *Reagents*

- Phosphate buffered saline (PBS).

- Assay buffer: 10 mM KH<sub>2</sub>PO<sub>4</sub>, 100 mM KCl, pH 7.4 at room temperature.
- [<sup>3</sup>H]-Flumazenil (18 nM for  $\alpha 1\beta 3\gamma 2$  cells; 18 nM for  $\alpha 2\beta 3\gamma 2$  cells; 10 nM for  $\alpha 3\beta 3\gamma 2$  cells; 10 nM for  $\alpha 5\beta 3\gamma 2$  cells) in assay buffer.
- Flunitrazepam 100  $\mu$ M in assay buffer.

5     • Cells resuspended in assay buffer (1 tray to 10 ml).

### *Harvesting Cells*

Supernatant is removed from cells. PBS (approximately 20 ml) is added. The cells are scraped and placed in a 50 ml centrifuge tube. The 10 procedure is repeated with a further 10 ml of PBS to ensure that most of the cells are removed. The cells are pelleted by centrifuging for 20 min at 3000 rpm in a benchtop centrifuge, and then frozen if desired. The pellets are resuspended in 10 ml of buffer per tray (25 cm x 25 cm) of cells.

15     *Assay*

Can be carried out in deep 96-well plates or in tubes. Each tube contains:

- 300  $\mu$ l of assay buffer.
- 50  $\mu$ l of [<sup>3</sup>H]-flumazenil (final concentration for  $\alpha 1\beta 3\gamma 2$ : 1.8 nM; for 20  $\alpha 2\beta 3\gamma 2$ : 1.8 nM; for  $\alpha 3\beta 3\gamma 2$ : 1.0 nM; for  $\alpha 5\beta 3\gamma 2$ : 1.0 nM).
- 50  $\mu$ l of buffer or solvent carrier (e.g. 10% DMSO) if compounds are dissolved in 10% DMSO (total); test compound or flunitrazepam (to determine non-specific binding), 10  $\mu$ M final concentration.
- 100  $\mu$ l of cells.

25     Assays are incubated for 1 hour at 40°C, then filtered using either a Tomtec or Brandel cell harvester onto GF/B filters followed by 3 x 3 ml washes with ice cold assay buffer. Filters are dried and counted by liquid scintillation counting. Expected values for total binding are 3000-4000 dpm for total counts and less than 200 dpm for non-specific binding if 30 using liquid scintillation counting, or 1500-2000 dpm for total counts and less than 200 dpm for non-specific binding if counting with meltilex solid

scintillant. Binding parameters are determined by non-linear least squares regression analysis, from which the inhibition constant  $K_i$  can be calculated for each test compound.

5 The compounds of the accompanying Examples were tested in the above assay, and all were found to possess a  $K_i$  value for displacement of  $[^3\text{H}]\text{-flumazenil}$  from the  $\alpha 2$  and/or  $\alpha 3$  and/or  $\alpha 5$  subunit of the human GABA<sub>A</sub> receptor of 100 nM or less.

EXAMPLE 1

10

3'-(5-Methyl-4-oxo-4,5-dihydroimidazo[4,5-c]pyridin-1-yl)biphenyl-2-carbonitrile

A mixture of 2-bromobenzonitrile (9.1 g, 50 mmol), 3-aminobenzeneboronic acid monohydrate (11.6 g, 75 mmol) and 15 tetrakis(triphenylphosphine)palladium(0) (1.73 g, 1.5 mmol) in 1,2-dimethoxyethane (50 ml) and 2 M sodium carbonate solution (25 ml) was heated at 80°C for 20 h. After cooling to ambient temperature the reaction was partitioned between ethyl acetate (400 ml) and water (400 ml). The organics were washed with brine (400 ml), dried over anhydrous sodium 20 sulfate, filtered and concentrated *in vacuo*. Purification of the residue by chromatography on silica gel, eluting with isohexane on a gradient of ethyl acetate (0-25%), gave 3'-aminobiphenyl-2-carbonitrile as a colourless oil which solidified on standing to afford a white solid (9.5 g, 98%):  $\delta_{\text{H}}$  (400 MHz,  $\text{CDCl}_3$ ) 3.79 (2H, br), 6.75 (1H, ddd,  $J$  8, 3 and 1), 6.84 (1H, dd,  $J$  3 and 3), 6.92 (1H, dd,  $J$  8 and 3), 7.25 (1H, dd,  $J$  8 and 8), 7.40 (1H, ddd,  $J$  8, 8 and 1), 7.50 (1H, dd,  $J$  8 and 1), 7.62 (1H, ddd,  $J$  8, 8 and 1), 7.73 (1H, dd,  $J$  8 and 1).

25 A suspension of 4-chloro-3-nitro-2-pyridone (1.00 g, 5.7 mmol), potassium carbonate (1.58 g, 11.5 mmol) and methyl iodide (4.07 g, 28.7 mmol) in *N,N*-dimethylacetamide (5 ml) were heated at 45°C for 18 h. The mixture was allowed to cool to ambient temperature, poured into water

(100 ml), layered with ethyl acetate (50 ml) and pH adjusted to 5 by the addition of 5N hydrochloric acid. The aqueous phase was extracted into ethyl acetate (2 x 100 ml), the combined organics were washed with water (2 x 100 ml) and brine (50 ml), dried over anhydrous sodium sulfate, 5 filtered and evaporated to give a pale yellow solid. The solid was triturated with diethyl ether (20 ml), filtered and washed with diethyl ether (5 ml) and isohexane (10 ml) and left to air dry, to give 4-chloro-1-methyl-3-nitro-1*H*-pyridin-2-one (0.71 g, 66%) as a pale yellow solid:  $\delta_H$  (360 MHz, DMSO) 3.36 (1H, dd, *J* 5 and 3), 3.54 (6H, s), 6.69 (2H, d, *J* 7), 10 8.09 (2H, d, *J* 7).

4-Chloro-1-methyl-3-nitro-1*H*-pyridin-2-one (0.71 g, 3.8 mmol) and 3'-aminobiphenyl-2-carbonitrile (0.73 g, 3.8 mmol) were dissolved in triethylamine (5.25 ml, 37.8 mmol) and DMSO (5 ml) and heated at 90°C for 18 h. The mixture was allowed to cool to ambient temperature then 15 poured onto water (150 ml). The aqueous phase was extracted with ethyl acetate (2 x 150 ml), the combined organics were washed with water (3 x 75 ml) and brine (50 ml), dried over anhydrous sodium sulfate, filtered and evaporated to give a brown solid. The solid was triturated with diethyl ether (20 ml), filtered and left to air dry, to give 3'-(1-methyl-3-nitro-2-oxo- 20 1,2-dihydropyridin-4-ylamino)biphenyl-2-carbonitrile (1.28 g, 98%) as a brown solid:  $\delta_H$  (400 MHz, CDCl<sub>3</sub>) 3.50 (3H, s), 6.24 (1H, d, *J* 8), 7.26 (1H, d, *J* 8), 7.34 (1H, d, *J* 8), 7.48 (2H, dd, *J* 4 and 2), 7.51-7.59 (2H, m), 7.60 (1H, t, *J* 8), 7.68-7.72 (1H, m), 7.81 (1H, dd, *J* 8 and 1), 10.47 (1H, s).

3'-(1-Methyl-3-nitro-2-oxo-1,2-dihydropyridin-4-ylamino)biphenyl-2-carbonitrile (0.11 g, 0.32 mmol) was suspended in ethyl acetate (10 ml) and ethanol (10 ml), platinum oxide (7.3 mg, 0.03 mmol) added and the mixture hydrogenated at 45 psi on a Parr hydrogenator for 2 h. The catalyst was filtered off through a glass fibre filter paper and the filtrate evaporated to give 3'-(3-amino-1-methyl-2-oxo-1,2-dihydropyridin-4- 25 30 ylamino)biphenyl-2-carbonitrile as an orange oil. The oil was dissolved in formic acid (4 ml) and heated at 95°C for 24 h. The mixture was allowed

to cool to ambient temperature and evaporated. The residue was made basic by the addition of concentrated ammonia solution, then diluted with water (100 ml) and extracted with dichloromethane (2 x 100 ml). The combined organic layer was washed with brine (50 ml), dried over 5 anhydrous sodium sulfate, filtered and evaporated to give a brown oil. The oil was purified by flash column chromatography on silica eluting with dichloromethane (+1% concentrated ammonia) on a gradient of methanol (2-4%). Collecting appropriate fractions, followed by trituration with diethyl ether (5 ml), gave 3'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-10 c]pyridin-1-yl)biphenyl-2-carbonitrile (64 mg, 61%) as a white solid:  $\delta_H$  (400 MHz,  $CDCl_3$ ) 3.69 (3H, s), 6.66 (1H, d,  $J$  7), 7.24 (2H, m), 7.52-7.58 (2H, m), 7.65-7.67 (2H, m), 7.69-7.74 (2H, m), 7.84 (1H, dd,  $J$  8 and 1), 7.99 (1H, s);  $m/z$  (ES $^+$ ) 327 (M $^{++}$ H).

15

EXAMPLE 2

1-[4-Fluoro-3-(5-fluoropyridin-3-yl)phenyl]-5-methyl-1,5-dihydroimidazo[4,5-c]pyridin-4-one

A solution of 5-fluoropyridin-3-ol (1.70 g, 15.0 mmol) in dry pyridine 20 (10 ml) at 0°C was treated with trifluoromethanesulfonic anhydride (4.23 g, 15 mmol). The solution was allowed to stir to room temperature over 12 h under nitrogen. The resulting solution was diluted with water (10 ml) and then extracted with ethyl acetate (50 ml). The organic layer was washed with 1N citric acid (2 x 50 ml) followed by a brine wash (50 ml). The organic layer was dried over anhydrous magnesium sulfate, filtered and evaporated to dryness. The crude product was filtered through a plug 25 of silica gel, eluting with isohexane containing 10% ether, and concentrated to give trifluoromethanesulfonic acid 5-fluoropyridin-3-yl ester as a clear oil (3.10 g, 84%), which was used without further purification:  $\delta_H$  (360 MHz,  $d_6$ -DMSO) 8.36 (1H, m), 8.76 (1H, d,  $J$  3), 8.83 (1H, d,  $J$  3).

A mixture of trifluoromethanesulfonic acid 5-fluoropyridin-3-yl ester (3.67 g, 15.0 mmol), potassium acetate (2.94 g, 30.0 mmol), bis(pinacolato)diboron (4.18 g, 17.0 mmol) and dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II) dichloromethane (0.37 g, 0.45 mmol) in 1,4-dioxane (45 ml containing 1% dimethylsulfoxide) was degassed with nitrogen for 1 h then heated at 90°C for 14 h. The reaction was cooled to ambient temperature and then concentrated *in vacuo*. The residue was stirred with 2N sodium hydroxide (300 ml) for 10 min then filtered. The filtrate was extracted with diethyl ether (2 x 200 ml) and the organics discarded. The aqueous component was cooled to 0°C then treated with 36% hydrochloric acid added dropwise over 15 min until pH 5. The resulting precipitate was allowed to stand at 0°C for 2 h then filtered and washed with ice-cold water. The sand-coloured solid was dried under vacuum (300 mmHg) over phosphorus pentoxide to afford 3-fluoro-5-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)pyridine as a yellow oil (3.0 g, 90%):  $\delta_H$  (400 MHz,  $CDCl_3$ ) 1.25 (12H, s), 7.75 (1H, dd,  $J$  5 and 1), 8.52 (1H, d,  $J$  3), 8.74 (1H, s).

4-Chloro-1-methyl-3-nitro-1*H*-pyridin-2-one was coupled to 3-bromo-4-fluorophenylamine, in the same way as in Example 1, to give 4-(3-bromo-4-fluorophenylamino)-1-methyl-3-nitro-1*H*-pyridin-2-one as a beige solid (2.0 g, 40%):  $\delta_H$  (400 MHz,  $d_6$ -DMSO) 3.36 (3H, s), 5.81 (1H, d,  $J$  8), 7.33-7.37 (1H, m), 7.45 (1H, t,  $J$  9), 7.64-7.68 (1H, m), 7.66 (1H, s), 9.73 (1H, s).

4-(3-Bromo-4-fluorophenylamino)-1-methyl-3-nitro-1*H*-pyridin-2-one was reduced as in Example 1 to give 3-amino-4-(3-bromo-4-fluorophenylamino)-1-methyl-1*H*-pyridin-2-one as a beige solid.

3-Amino-4-(3-bromo-4-fluorophenylamino)-1-methyl-1*H*-pyridin-2-one was cyclised as in Example 1 to give 1-(3-bromo-4-fluorophenyl)-5-methyl-1,5-dihydroimidazo[4,5-*c*]pyridin-4-one as a white solid (0.91 g, 82%):  $\delta_H$  (400 MHz,  $d_6$ -DMSO) 3.53 (3H, s), 6.52 (1H, d,  $J$  7), 7.58-7.72 (3H, m), 8.08 (1H, dd,  $J$  6 and 3), 8.33 (1H, s).

1-(3-Bromo-4-fluorophenyl)-5-methyl-1,5-dihydroimidazo[4,5-  
c]pyridin-4-one was coupled to 3-fluoro-5-(4,4,5,5-tetramethyl-  
[1,3,2]dioxaborolan-2-yl)pyridine, in the same way as in Example 1, to give  
1-[4-fluoro-3-(5-fluoropyridin-3-yl)phenyl]-5-methyl-1,5-  
dihydroimidazo[4,5-c]pyridin-4-one as an off-white solid (62 mg, 59%):  
δ<sub>H</sub> (400 MHz, *d*<sub>6</sub>-DMSO) 3.69 (3H, s), 6.36 (1H, s), 7.23 (1H, d, *J* 7), 7.40-  
7.56 (3H, m), 7.68-7.69 (1H, m), 7.94 (1H, s), 8.57 (1H, d, *J* 3), 8.66 (1H, d,  
*J* 1); *m/z* (ES<sup>+</sup>) 339 [MH<sup>+</sup>].

10

### EXAMPLE 3

#### 5,2'-Difluoro-5'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-c]pyridin-1-yl)- biphenyl-2-carbonitrile

2-Bromo-4-fluorobenzonitrile was converted to 4-fluoro-2-(4,4,5,5-  
15 tetramethyl-[1,3,2]dioxaborolan-2-yl)benzonitrile as described in Example  
2 to give a brown solid: δ<sub>H</sub> (400 MHz, CDCl<sub>3</sub>) 1.39 (12H, s), 7.18-7.23 (1H,  
m), 7.57 (1H, dd, *J* 9 and 3), 7.72 (1H, dd, *J* 9 and 5).

1-(3-Bromo-4-fluorophenyl)-5-methyl-1,5-dihydroimidazo[4,5-  
c]pyridin-4-one (0.64 g, 2.0 mmol), 4-fluoro-2-(4,4,5,5-tetramethyl-  
20 [1,3,2]dioxaborolan-2-yl)benzonitrile (0.99 g, 4.0 mmol) and potassium  
phosphate (0.68 g, 3.2 mmol) were placed in a flask with 1,4-dioxane (3  
ml), and water (2 drops) was added. The mixture was degassed with  
nitrogen for 15 min before adding tris(dibenzylideneacetone)-  
dipalladium(0) (90 mg, 0.10 mmol) and tri-*tert*-butylphosphine (10% wt in  
25 hexanes, 0.20 ml, 0.10 mmol). The resulting mixture was heated at 70°C  
for 16 h. The reaction mixture was allowed to cool, and then partitioned  
between dichloromethane (100 ml) and water (100 ml). The organic phase  
was washed with water (100 ml) and brine (100 ml), dried over anhydrous  
magnesium sulfate, filtered and pre-adsorbed onto silica. Purification by  
30 flash column chromatography on silica gel, eluting with dichloromethane  
on a gradient of ethanol (1-4%), gave a white solid. This solid was

triturated with ethanol and filtered, yielding pure 5,2'-difluoro-5'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-*c*]pyridin-1-yl)biphenyl-2-carbonitrile as a white solid (423 mg, 60%):  $\delta_H$  (400 MHz, *d*<sub>6</sub>-DMSO) 3.54 (3H, s), 6.69 (1H, d, *J* 7), 7.59-7.62 (2H, m), 7.71 (1H, t, *J* 9), 7.79 (1H, dd, *J* 9 and 2), 5 7.84-7.90 (2H, m), 8.16 (1H, dd, *J* 9 and 6), 8.39 (1H, s); *m/z* (ES<sup>+</sup>) 363 [MH<sup>+</sup>].

#### EXAMPLE 4

10 1-[4-Fluoro-3-(pyridin-3-yl)phenyl]-5-methyl-1,5-dihydroimidazo[4,5-*c*]pyridin-4-one

15 1-(3-Bromo-4-fluorophenyl)-5-methyl-1,5-dihydroimidazo[4,5-*c*]pyridin-4-one was coupled to 3-pyridylboronic acid, in the same way as in Example 1, to give 1-[4-fluoro-3-(pyridin-3-yl)phenyl]-5-methyl-1,5-dihydro-imidazo[4,5-*c*]pyridin-4-one as an off-white solid (50 mg, 32%):  $\delta_H$  (400 MHz, CDCl<sub>3</sub>) 3.69 (3H, s), 6.38 (1H, d, *J* 7), 7.22 (1H, d, *J* 7), 7.40-7.49 (3H, m), 7.54 (1H, dd, *J* 7 and 3), 7.90-7.94 (2H, m), 8.70 (1H, dd, *J* 5 and 2), 8.84 (1H, s); *m/z* (ES<sup>+</sup>) 321 [MH<sup>+</sup>].

20

#### EXAMPLE 5

25 5-Methyl-1-(2,2',3'-trifluorobiphenyl-5-yl)-1,5-dihydroimidazo[4,5-*c*]pyridin-4-one

30 1-(3-Bromo-4-fluorophenyl)-5-methyl-1,5-dihydroimidazo[4,5-*c*]pyridin-4-one was coupled to 2,3-difluorobenzeneboronic acid, in the same way as in Example 1, to give 5-methyl-1-(2,2',3'-trifluorobiphenyl-5-yl)-1,5-dihydroimidazo[4,5-*c*]pyridin-4-one as an off-white solid (32 mg, 40%):  $\delta_H$  (400 MHz, *d*<sub>6</sub>-DMSO) 3.54 (3H, s), 6.61 (1H, d, *J* 7), 7.35-7.41 (1H, m), 7.48 (1H, dd, *J* 8 and 7), 7.55-7.67 (3H, m), 7.77-7.81 (2H, m), 8.40 (1H, s); *m/z* (ES<sup>+</sup>) 356 [MH<sup>+</sup>].

EXAMPLE 6

4,2'-Difluoro-5'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-c]pyridin-1-yl)biphenyl-2-carbonitrile

5 2-Bromo-5-fluorobenzonitrile was converted to 5-fluoro-2-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)benzonitrile as described in Example 2 to give a straw-coloured solid:  $\delta_H$  (360 MHz,  $CDCl_3$ ) 1.38 (12H, s), 7.27 (1H, ddd,  $J$  8, 8 and 2), 7.39 (1H, dd,  $J$  9 and 2), 7.90 (1H, dd,  $J$  8 and 6).

10 1-(3-Bromo-4-fluorophenyl)-5-methyl-1,5-dihydroimidazo[4,5-c]pyridin-4-one was coupled to 5-fluoro-2-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)benzonitrile, in the same way as in Example 1, to give 4,2'-difluoro-5'-(5-methyl-4-oxo-4,5-dihydroimidazo[4,5-c]pyridin-1-yl)biphenyl-2-carbonitrile as an off-white solid (360 mg, 55%):  $\delta_H$  (400 MHz,  $d_6$ -DMSO) 3.54 (3H, s), 6.67 (1H, d,  $J$  7), 7.61 (1H, d,  $J$  7), 7.69 (1H, t,  $J$  9), 7.75-7.87 (4H, m), 8.09 (1H, dd,  $J$  9 and 3), 8.38 (1H, s);  $m/z$  (ES $^+$ ) 363 [MH $^+$ ].